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THE SUPPOSED ACTION OF POTASSIUM PERMANGANATE WITH PLANT PEROXIDASES

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REED[1] has recently reported experiments which he believes throw a new light on the mechanism of oxidation in living tissues. The experiments relate to the reactions involved in the process of oxidation by means of peroxidases. To a horseradish extract, which in itself was incapable of bringing about the oxidation of potassium iodide or of gum guaiac, he added concentrated potassium permanganate solution until the permanganate was no longer reduced. He then added a small excess of horseradish extract to reduce any free permanganate present. On filtration a clear, rather deep yellow solution was obtained, which, when mixed with solutions of potassium iodide, gum guaiac, or pyrogallol, caused rapid oxidations of those substances. REED'S interpretation of these experiments is that the peroxidase of the horseradish extract combines with oxygen from the permanganate, thus forming a new compound which readily gives up oxygen to other compounds. He concludes, therefore, that in oxidation processes catalyzed by peroxidases two reactions are involved: first, a combination of the peroxidase with oxygen from substances acting as oxygenases; and second, a transfer of this oxygen to the substances oxidized by means of peroxidases. Thus he believes the mechanism of oxidation in living tissues is explained.

Contrary to REED'S belief, this interpretation throws no new light on the mechanism of oxidation in living tissues, but is quite in harmony with the older views of TRAUBE, BACH, ENGLER, and KASTLE and LOEVENHART. Moreover, since manganese compounds themselves are capable of bringing about oxidations, the correctness of REED'S view ascribing the oxidations in the mixtures with which he worked to peroxidase activated by oxygen from the postassium permanganate is at least open to question. That the presence of peroxidases is not necessary to bring about the observed reactions is shown by the following experiments:

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[1] REED, G. B., The mode of action of plant peroxidases. BOT. GAZ. **62**:233–238. 1916.

1. Two-tenths of a gram of dried white of egg was dissolved in 10 cc. of water. To this solution 2 drops of saturated solution of potassium permanganate were added. The pale brown filtrate from this mixture gave intense oxidase reactions with guaiac, potassium-iodide-starch, and pyrogallol.

2. One gram of Witte's peptone was dissolved in 20 cc. of water and 5 drops of saturated potassium permanganate solution were added. With the pale brown filtrate the 3 oxidase reactions just mentioned were carried out. All were strongly positive.

3. To about half a gram of tyrosin mixed with water 2 drops of a 5 per cent solution of potassium permanganate were added. The brownish mixture gave a clear brown filtrate which oxidized potassium iodide, guaiac, and pyrogallol.

4. One-half gram of tyrosin was dissolved in hot water. To the boiling solution 3 drops of a 5 per cent solution of potassium permanganate were added. The pale brown filtrate from the mixture gave the 3 oxidase reactions. This filtrate was boiled and allowed to stand overnight, but no further precipitate was formed. The filtrate still gave all the oxidase reactions.

5. To a solution of 1 gram of glucose, 2 drops of a saturated potassium permanganate solution were added. The mixture was warmed until the purple color had given way to light brown. The filtrate gave the oxidase reactions distinctly. Fructose treated in the same way gave strong reactions with guaiac and with potassium-iodide-starch, but none with pyrogallol.

6. To a boiling solution containing 3 drops of a 5 per cent potassium permanganate solution in 10 cc. of water, glycerine was added drop by drop until the purple was replaced by brown. The filtrate from the brown precipitate was pale straw-colored. It gave all the oxidase reactions.

7. One cc. of salicylic aldehyde reduced quickly in the cold 2 drops of a 5 per cent solution of potassium permanganate, forming a brown precipitate. The pale straw-colored filtrate gave reactions with potassium-iodide-starch and with guaiac.

8. Methyl alcohol and ethyl alcohol when gently warmed reduced potassium permanganate to a colorless solution, which when filtered from the brown precipitate gave no oxidase reactions.

9. Formaldehyde and acetaldehyde reduced potassium permanganate in the cold, giving brown or black precipitates and colorless solutions which gave no oxidase reactions. This result was to be expected from the action of methyl alcohol and ethyl alcohol.

10. A trace of manganese peroxide shaken up in water oxidized guaiac, potassium iodide (in neutral solution), and pyrogallol.

In all these experiments, a large excess of the organic compounds was used, so that the solutions would be free from potassium permanganate in the sense in which REED considered his solutions free from unreduced potassium permanganate. The potassium iodide reactions were carried out in solutions of the same strength as those used by REED. In all cases the reagents and control mixtures failed to give the oxidase reactions. The brown filtrates as well as the colorless ones contained manganese.

It appears from these experiments that in the reduction of potassium permanganate by organic substances in neutral solutions, hydrated peroxides of manganese are formed, which are held in solution and which though they are reduction products of permanganic acid are still capable of carrying out oxidations. When the permanganate is still further reduced, the water-clear filtrate which still contains manganese compounds no longer gives the oxidation reactions described. By careful reduction both stages can be obtained with the same compound (glycerine, glucose).

Inasmuch as the brown solutions contain manganese not reduced to its lowest state of oxidation, and since manganese peroxide itself brings about the oxidation of guaiac, potassium iodide, and pyrogallol, it becomes extremely probable that the oxidation phenomena observed by REED were brought about by peroxides of manganese and not by activated plant peroxidases. Moreover, since a number of substances acting on potassium permanganate give mixtures which oxidize other compounds, there is no evidence in REED'S experiments that the reduction of the potassium permanganate was brought about by plant peroxidases. His conclusions, therefore, drawn from reactions which are common to many organic substances and which are not known to be properties of peroxidases, are too sweeping for the experimental grounds upon which they are based.

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